WELLCOME INSTITUTE LIBRARY
WelMOmec
Pam
WB460
1911
S65r

From THE LANCET-CLINIC, April 8, 1911.

WELLCOME INSTITUTE LIBRARY

RESEARCH WORK IN MECHANICAL THERAPEUTICS.*

BY DR. RALPH KENDRICK SMITH.
BOSTON, MASS.

303850
Lyrax 611.

H. W. CONN, Professor of Biology in Wesleyan University, in a recent work said: "The conclusion that the living body is a machine, involving as it does a mechanical conception of life, is one of the most extreme philosophical importance, and no one interested in the philosophical conception of nature can fail to have an interest in the problem of the strict accuracy of the statement that the body is a machine." Prof. Conn found it important enough to write a whole book upon this subject.

It is largely because of my earnest belief in the truth of this statement that I venture to address you upon the subject of mechanical therapeutics. If it is true that the patient is a living machine, it must necessarily follow that the mechanical treatment of this machine when it is out of order should be an important part of the physician's equipment, whatever his specialty or his school of practice or his theories. But it is only in very recent years that the science and the art of mechanical treatment have advanced to a point which compels the attention of the medical world. It was not many years ago when the little, neglected specialty of orthopedics was supposed to be confined to club-feet, flat-foot, Potts' disease, scoliosis, and such obvious conditions, while the lay public had the word pretty thoroughly fixed in its mind as applying only to treatment of the feet. But now we find orthopedics advancing rapidly into one of the busiest and foremost specialties, and in fact invading, if I may use the word, no inconsiderable part of the general field of practice. Why? Because the body is a machine, and because, therefore, mechanical treatment is indicated to a far greater extent than was dreamed of a few years ago.

Please do not misunderstand me. In placing emphasis upon mechanical treatment it is farthest from

* Read before the American Association of Clinical Research, Boston, Mass., September 28 and 29, 1910.

SMITH

WB 460 1911 S65r

my intention to be discourteous or unscientific enough to underrate or detract one iota from the importance or value of the splendid research work along the lines of internal medication already presented and to be presented at this meeting. If this is clearly understood, perhaps I may be permitted to continue to confine myself entirely to the mechanical aspect of therapeutics, speaking of what I know and put my trust in, without intending any comparison with medication.

It would be presumptuous to attempt to cover, even in outline, in one brief paper, the entire subject of mechanical therapeutics. I have no intention of covering the great field of orthopedic surgery in the few minutes allotted to me, even were I competent to do so, which is very far indeed from being the case. The subject of this paper is meant to apply to those procedures in mechanical therapeutics which have recently been adapted to an entirely new class of cases from those heretofore classified under the head of orthopedic. So we will dismiss entirely, as outside the scope of this paper, the vast and brilliant field of orthopedic surgery from the classic standpoint, leaving to those more able the exposition of the usual treatment of deformities and diseases of the bones and joints, while we go on into the mysteries of the great and comparatively unknown field of mechanical treatment of those conditions which the medical profession and public have hitherto looked upon and classified as medical.

What can be more fascinating to the scientific physician, regardless of his so-called school of practice, than the possibility of being able to in some degree alleviate the sufferings of humanity in a shorter time, and perhaps more permanently and thoroughly, and without the necessity of introducing into the body any foreign substance? We are engaged in the strenuous pursuit of scientific truth, and if it can be proven that many conditions and symptoms result from mechanical causes, and if we find that by mechanical means we can most easily and thoroughly remove this mechanical cause, I know you will unite with me in hailing with joy the advent of this or any other procedure which could thus tend toward the goal which is the ambition of all followers of the healing art.

One of the most important factors in the confirmation or proof of the anatomical cause or complication of the symptom-complex in a given case is the X-ray picture. Until recently the X-ray was used for frac-

WELLCOME INSTITUTE LIBRARY
Coll. welMOmec
Call No. pam WB460 1911 S65r
22500912475

tures, dislocations and diseases of bones only, but now, thanks to the remarkable work being done by a few able orthopedic men, the X-ray is opening up the beginning of a marvelous and seemingly unlimited field of possibility in the way of diagnosis of visceral disease. By the use of bismuth, radiographs may be taken of the entire alimentary tract. These pictures, when made by an expert, are positively startling in their vivid portrayal of the shape, position, and even of the functional activity of the stomach and colon. You are of course already familiar with the aid which can be thus given to you in the confirmation of your diagnosis of neoplasms and ulcers of the alimentary tract, but it is for quite a different purpose that I am calling your attention to the X-ray pictures of the digestive organs. We are considering to-day the mechanical aspect of the body with a view to mechanical treatment of disease. Therefore, if our X-ray pictures disclose a perfectly obvious mechanical change in the position and relation of the abdominal organs, it is of inestimable advantage to us. The methods which we have been forced to use heretofore for the purpose of outlining the size, shape and posture of the colon have been so faulty and so inexact as to lead to unfortunate conclusions and to startling differences of opinion by different examiners of the same case. Possibly the best way I can illustrate this point to you is to exhibit this group of radiographs of a patient of mine suffering from various abdominal and reflex symptoms. Physical examination by competent consultants was not productive of any definite conclusions. But how clear and exact becomes the diagnosis when we look at these beautiful pictures. Here is an abnormal mechanical condition which is perfectly capable of producing the train of symptoms presented. You see this is not simply the sagging of the transverse colon like a hammock, which we find very frequently indeed in cases of chronic constipation and dyspepsia and various indigestions, but it is a complete ptosis of the colon, involving both the hepatic and splenic flexures. In other words, the whole colon lies in the brim of the pelvis. Perhaps also you will be interested in examining more in detail the conformation of the lumen of the colon. This plate shows you a picture which somewhat upsets the old-fashioned teaching of the colon being a cylindrical tube. It is unnecessary to speak further of the use of X-ray, as you are already familiar with the information which it gives us of the

position and condition of the vertebral articulations, the hips and other joints. I wish to acknowledge my indebtedness to Dr. Percy Browne, of Boston, for the radiographs I have just shown you. He is a pioneer worker in the new field of X-radiance of internal organs.

Bloodless surgery is replacing the knife in other procedures than the famous Lorenz congenital hip cases. Manipulation is certainly becoming the vogue to-day in many quarters. Many orthopedic surgeons have used manipulation under ether for years for some club foot cases, for stiffened ankle and adhesions of various joints, and lately for sacro-iliac lesions, but now a number of men seem to be interested in manipulation without anesthesia. In the out-patient department of the Massachusetts General Hospital, during the past two months, I have had opportunity to care for most of the sacro-iliac cases. During this time ether was not used on a single case. Even the worse case of them all responded rapidly to specific corrective manipulation without ether. In some of these cases I omitted the usual procedure of adhesive strapping and belt, and found the cases recovered as rapidly as with them. There are cases, however, which should have support for a reasonable period of time.

In this connection also may be considered the claims advanced by Dr. Ehrenfried, of the Childrens' Hospital, Boston, who found that club foot in infancy could be treated more satisfactorily by maniuplation and plaster retention than by operative interference.

Anterior poliomyelitis is a subject everybody, in and out of the profession, is interested in to-day, so it is not out of place to refer to it here, as the leading authorities admit that, in spite of unrelenting systematic research, they have been unable to isolate the bacterium or to find a remedy. All agree, however, to the principle voiced by the department of orthopedic surgery of Harvard Medical School in the summary of methods of treatment in the *Boston Medical Journal,* of June 30 last, in these words, "Massage should be given the highest place in all stages of this affection."

"The Relation of Posture to Human Efficiency and the Influence of Poise Upon the Support and Function of the Viscera," by Joel E. Goldthwait, M.D., Boston, is the significant title of a most remarkable contribution to the literature of this new phase of therapeutics of which we are talking. He says:

"The human organism resembles in many ways a delicately balanced machine made up of many parts each related to the others, and that which we call perfect health is simply the proper correlation of all of these many parts. Anything which results in a departure from this correlation or balance means strain or friction and represents a distinct waste of energy so that the efficiency is lessened. Under such conditions some one part may be. and usually is, strained more than the others, but it must be remembered, nevertheless, that no one part can be strained without affecting the whole.

"All of the visceral functions, as well as the higher mental processes, require an adjustment of the organism as a whole which must make possible wide latitude in the amount of energy that each part can reasonably use.

"Whenever the body is used so that the center of gravity is forward of the normal plane, the posterior or spinal muscles are subjected to greater use or strain than is normal, and if this is continued the muscles weaken, with the result that the ligaments are strained, causing the common back pains or points of tenderness. If the muscles weaken, their blood supply will naturally be less abundant than normal, and as the lumbar arteries and the intercostal arteries supply the muscles and send a branch into the spinal canal on the level of each vertebra, furnishing part of the blood supply of the spinal cord, it would seem probable that, if the flow of blood to the muscles were less active than normal, the amount of blood received in the branch which supplies the spinal cord will also be less. Whether this is the explanation of the common association of neurasthenic symptoms with the conditions of spinal weakness, or whether as the result of the weakness of the spinal muscles the motions of the spine are made less freely and thus lead to venous stasis, is entirely problematical. Certain it is, however, that these two groups of symptoms are commonly met with in the same individual, and that the rapid improvement in the nervous symptoms which so often follows the relief of spinal weakness would suggest some such explanation.

"If the body is held erect and well poised, there must be the greatest amount of energy available for whatever function the individual may choose or be forced to perform. The muscular forces are used with least waste, the viscera are most favorably situated for function, the circulation in the spinal cord as well as in the rest of the body is subjected to the least interference, so that there is the least possible waste of either mental, nervous or physical energy, and the spirit of the individual has its greatest potential.

"The recognition of the many problems suggested in such a paper as this means that the physician has a higher function than the mere treatment of local conditions, however commendable this may be. It means at once that our work must be judged upon the basis of the ultimate cure or general efficiency rather than simply the immediate relief of some local lesion. This oftentimes represents only the beginning of

our work. The flat foot, the tuberculosis of the lungs or whatever the special lesion may be should, of course, be corrected or relieved in so far as it is possible so to do, but our care should not stop until the highest degree of physical efficiency for that individual is obtained.

"It means that with pulmonary tuberculosis the simple insistence on good hygiene with fresh air and food is not all that the physician is called upon to perform. It means that in the treatment of disturbances or displacements of the pelvic organs, it is only half doing the work if the condition is simply treated locally, while an imperfect posture which may have been largely responsible for the trouble is allowed to go uncorrected.

"It means that in the various abdominal visceral ptoses there is more to do than treat locally a stomach which may have sagged out of place by irrigation or drugs, or to even suture a kidney in place because it too has sagged. Operations, stomach washing and the various forms of local treatment for all such conditions are undoubtedly necessary and may give temporary relief, but none of these can be expected to really cure the lesion until the whole body can be used in such a way that there is the least possible tendency to visceral displacement and there is the greatest amount of energy available for the proper nutrition and function of all the structures of the body. Until the question is approached in some such way as this, and the body is considered first with the local condition second, or at least with due regard to the first, until then this large class of abdominal disturbances will be unsatisfactorily treated, either by the internist or the surgeon, and our profession will be reproached for that for which, judging from many of the results obtained in such cases, reproach seems deserved. It is foolish, for instance, to treat the weakly child that stands with the shoulders drooping forward and with the abdomen relaxed, by simply giving tonics."

Although the treatment of scoliosis belongs properly to the classical classification of orthopedic surgery, and as such we decided to omit it from consideration in this paper, I cannot refrain from referring to the fact that the *modern* treatment of scoliosis, as exemplified by Lovett in his splendid clinic at the Children's Hospital, is a brilliant departure from tradition and is right in line with our subject and should be considered in connection with Goldthwait's work on poise. I would even go so far as to say that no man should practice any kind of mechanical treatment of the torso without frequent and thorough reference to Lovett's wonderful little book entitled, "Lateral Curvature of the Spine and Round Shoulders."

As an example of the thorough character of the research work done by Lovett, before drawing his conclusions, I desire to quote the following:

"A young male cadaver was laid on the face, and straps passed around the body at the level of the right shoulder and the right hip. These straps were then fastened to the left side of the table, holding the shoulder and hip against pressure from the left. A strap was then passed around the left side of the thorax and by means of a spring balance pulled to the right. The side deviation of the spine was then measured at four levels, the measurements being taken from a base-line connecting the cervical spine and the sacrum. The measurements were all made from pins driven into the spinous processes. Three experiments were made with a side pull of twenty-five pounds and the results were recorded.

"A Sayre head-sling was then put around the head of the cadaver still lying on the face, and a traction force of seventy-five pounds was made in the length of the spine, the feet of the cadaver being fastened to the table. While the traction on the head was thus in force the same side pull of twenty-five pounds was made as before and the results noted. Two experiments of this sort were made. It was found that the spine without traction was displaced to the side nearly twice as far by a definite side pull as by the same amount of side pull when traction was being made.

"A confirmatory experiment was made on a healthy boy of fifteen, using seventy-five pounds of head traction and fifteen pounds of side pull. The result was the same.

"The conclusion is that extension of the spine by an upward pull on the head is a corrective force in the normal spine, but that much *more* force is required to accomplish a certain amount of side correction than is the case if the force is applied from the side.

"The other conclusion is that to secure the maximum of side displacement from a given amount of side pressure the spine must be slack and *not* stretched in its length."

Probably the most startlingly radical stand in mechanical therapeutics ever taken within the ranks of the medical profession was that announced this very year by Albert Abrams, M.D., former director of the medical clinic of Stanford University Medical Department, in his remarkable book entitled "Spondylotheraphy." This is a text-book of treatment by spinal methods. In his preface the author says:

"The subject of spinal therapeutics has received less attention from the medical profession than it deserves. Even the laity know that the cold applied to the back of the neck may arrest hemorrhage from the nose, and that heat applied to the small of the back may hasten menstruation. The profound and far-reaching physiologic truths which underlie these simple phenomena have either been ignored or only given inconsiderable attention.

"Others, less scientific but more astute, have determined empirically that manipulation of the spine does sometimes

cure conditions that have failed of cure in the hands of experienced physicians So it has come to pass that schools of practice exploiting spinal manipulation as a cure-all have arisen. Neither the fury of tongue nor the truculence of pen can gainsay the confidence which these systems of practice have inspired in the community.

"The author was led to a deeper study of spinal therapeutics in investigating various visceral reflexes which bear his name. As the years passed on, he ascertained that a number of pathologic conditions could be more easily and certainly controlled by spondylo-therapeutic means, than by the conventional measures.

"The successful practice of spondylotherapy requires knowledge, observation and experience of the highest kind, and is comparable to the best effort in any other department of scientific medicine."

Dr. Abrams uses for his therapeutic measures percussion upon the vertebral spines and in some cases electrical stimulation. He percusses with a vibrator giving a direct percussion stroke or with an ordinary plexor and pleximeter, or tack hammer and piece of linoleum. He has demonstrated many new muscular and organic reflexes from spinal percussion, and claims to cure many diseases by this method exclusively. His most amazing claims are those of the complete cure of aneurism of the aorta by percussion upon the seventh cervical spine. His treatment is never general. It is most specific, usually on a single vertebra for some particular organ.

Another most interesting and frank statement of brilliant results secured clinically by mechanical methods by a well known medical authority was published in the *New York Medical Journal,* February 8, 1908, entitled "The Hand as a Therapeutic Agent," by J. Madison Taylor, A.M., M.D., of Philadelphia. He says:

"If half as much scientific research had been expended on the principles governing manual treatment as upon pharmacology, the hand would be esteemed to-day on a par with drugs in acceptability and power. No single therapeutic agent can be compared in efficiency with this familiar but perfect tool.

"So great is the potency of this measure that in recent years a vigorous cult is working in most communities, cures, or satisfactory ameliorations of conditions, which the 'regular profession' have been unable to relieve.

"It was both amusing and pathetic to observe how ludicrously reluctant physicians, on whom or their families I have worked 'unbelievable miracles,' were to accept the facts.

"It is my conviction that refinements in the education of

touch, the perceptive hand, will form an essential part of clinical diagnostic as well as therapeutic teaching in the future.

"The educated hand can become an exceedingly important instrument in therapeutics. By its use some morbid states can be more promptly and others more completely removed than by other known means.

"There is no more warranty in denying extraordinary results attained by manual therapy than in legerdemain, in painting, in sculpture, in violin or piano playing. The body is like a piano or harp, to be played upon at will. All that is needed is to work out the principles on a practical physiologic basis.

"By a five or ten minutes' use of my hands I am often able to so supplement other remedial agents as to relieve, often permanently, and in a vastly shorter space of time than formerly, a large variety of ailments, sufferings, and diseased states, so that I feel impelled to urge attention to these valuable measures upon all practicing physicians."

In the *Boston Medical and Surgical Journal,* August 13, 1908, p. 207, Charles F. Painter, M.D., of Boston, cites a case of sacro-iliac dislocation and arthrodesis. (Until recently the medical profession ridiculed the osteopathic diagnosis of sacro-iliac dislocation, declaring it to be an impossibility). This patient, a teamster, had pain in lower back and down left leg for six months, so severe as to incapacitate him for work. He had been treated for rheumatism, strapped with adhesive plaster and plaster jacket, but all in vain. Then the author says:

"An ether manipulation was undertaken, the patient after anesthetization being placed upon a hard table face downward. The left thigh was then forcibly hyperextended and continuous pressure was made over the left side of the sacrum. There was a loud snapping sound noticed while this manipulation was going on, which was accepted as evidence, though there was no other to substantiate it, of the replacement of the sacrum in a proper relation with the ilium. The pain was wholly relieved by the manipulation. He had very little pain and walked easily (after two weeks in bed) and with practically no list. He was discharged from the hospital at this time and returned to his occupation, which he was able to follow for nearly two months."

In the *Boston Medical and Surgical Journal,* March 31, last, Lloyd T. Brown, M.D., has an article entitled, "Growing Pains—A Possible Mechanical Explanation." Dr. Brown finds that children so affected are generally loose-jointed, have bad posture, pronated feet, knock-knees or weak spine and drooped shoulders. He finds that the balance of the muscles is lost,

and protection which ought to be given to the joints is removed and that there must necessarily result strains and the consequent relaxations to the joints involved. This causes a lack of support to the viscera by the spine and the abdominal wall, and consequently a downward pull of the transverse colon may be a cause of the ptoses so commonly seen in this type of child. He says: "These ptoses may be sufficient cause for even the severest digestive symptoms." He also

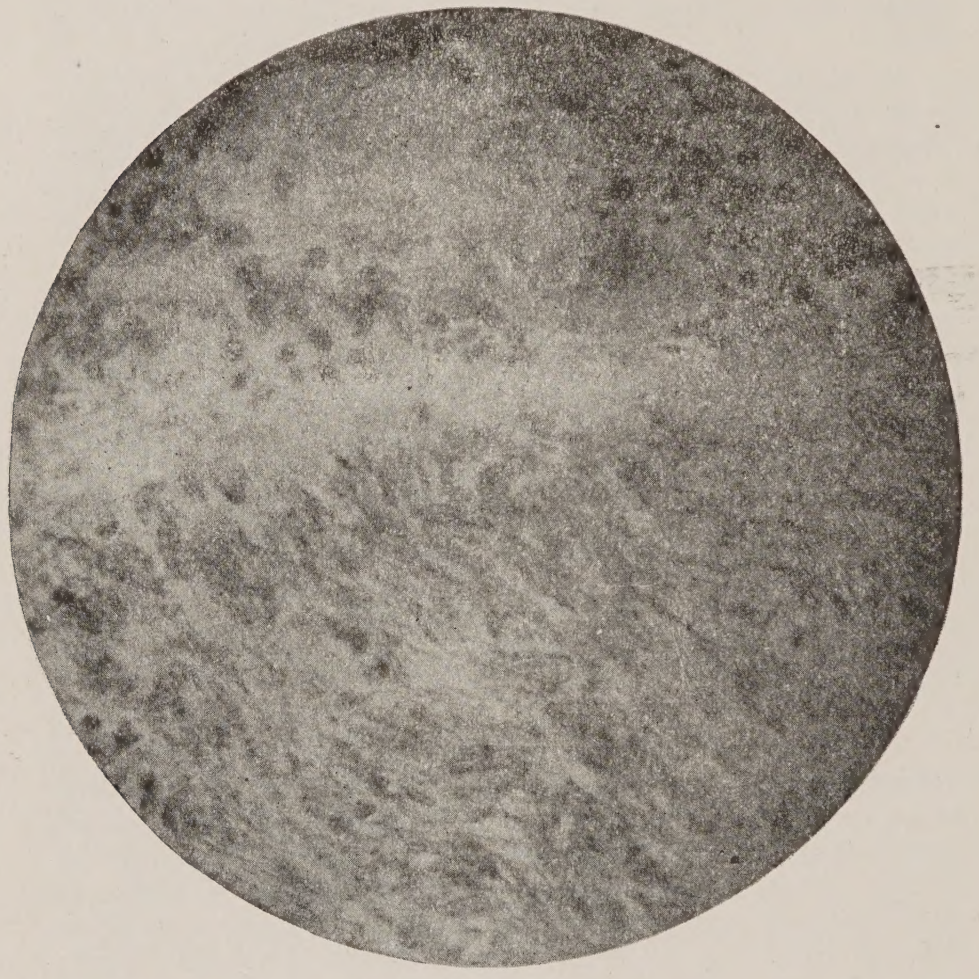

FIG. 18.—Posterior spinal ganglion. Degenerated nerve fibers in lower two-thirds of cut. The upper part is tissue surrounding ganglion, showing diapedesis. A few corpuscles are seen entering the nervous structure. Donaggio, method III (Hall and Herxheimer). X 400.

says that sacro-iliac strain may be a marked factor in growing pains in children. His treatment, which consists of various pieces of apparatus for artificial support, I cannot possibly bring myself to approve of in the cases of such young children, when we know that manual readjustment, together with massage and exercises, will restore to the normal without the evil results usually found in some degree in cases where apparatus is necessary in growing children.

While personally I believe, as a result of observation and experiment both in private practice and hospital, that mechanical readjustment, or what might be termed anatomical correction or change of poise or posture, is more effective and both quicker and more permanent in its curative aspect, I am not oblivious to the various other mechanical methods of treatment, such as hydrotherapy, vibration, massage, exercises, etc. One of the most interesting monographs I have read for some time is an article by the Drs. Cyriax, of London, on "The Manual Treatment of the Abdomi-

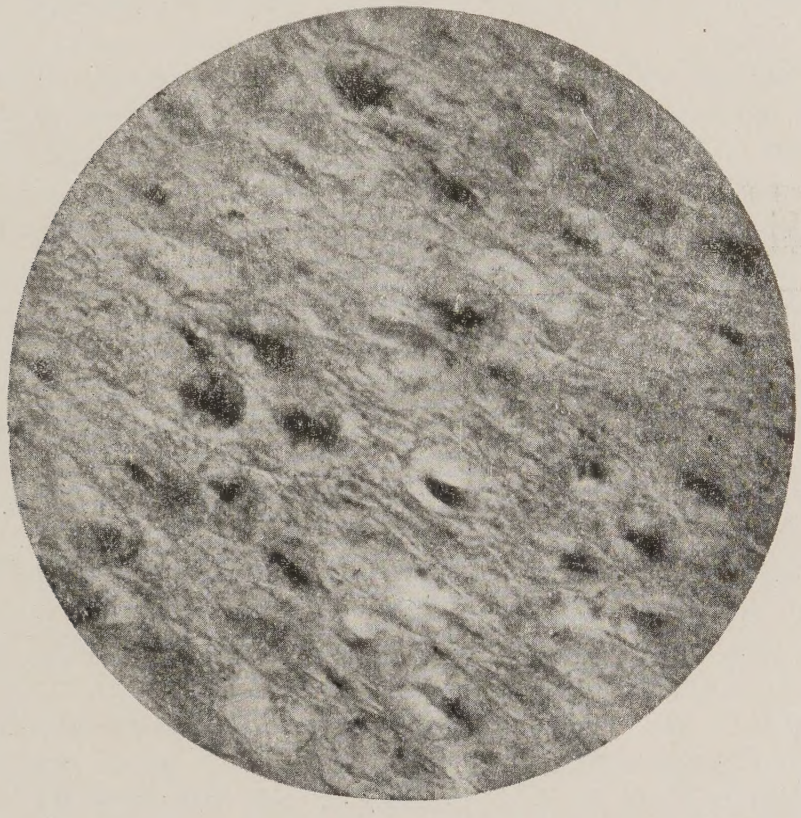

FIG. 19.—Degenerated nerve fibers just after leaving posterior spinal ganglion (from same section as preceding). Donaggio. X 400.

nal Sympathetic." They have worked out a system of digital treatment of the sympathetic nerves, getting as directly upon plexuses as possible. They use the word "friction" as applying to their technique. They mean by this that they produce friction between the nerve and the underlying surface of the tissues between the nerve and their fingers, instead of having the friction occur between their fingers and the surface of the body as is done in the superficial rubbing of ordinary massage. In other words, they never let their fingers slip on the skin. They move the skin and superficial structures over the nerve they wish to stimulate, if

they use friction, or to inhibit if they wish to decrease its activity. They reach the sympathetics indirectly by administering this treatment to the spine, utilizing the spinal nerves as a means of reflex communication. They also work directly over the solar plexus, the renal plexus, hypogastric plexus, bladder plexus, and the coccygeal plexus. In the latter case the treatment may be applied bimanually. The doctors in conclusion say: "In obstinate and intractable abdominal conditions we have found that the direct method is one of the strongest and most effective methods at our command—it will frequently succeed when everything else has failed."

I cannot refrain from stating, from a sense of fairness, that a careful perusal of this article, which appeared in the *New York Medical Journal,* July 23, last, fails to disclose anything beyond a paraphrasing of the technique as taught in the osteopathic colleges for the past twenty years. It is interesting, however, to see osteopathic technique exploited in prominent medical journals, even when it is offered as new by practitioners of the older school.

Last February, in St. Luke's Hospital, in Chicago, Mrs. V. was operated upon by a member of the staff. It was an hysterectomy. This was followed by hiccoughing every ten seconds for forty-eight hours. All methods of treatment known in the regular practice were used, including electricity, carbonized water, pressure, holding breath, hot and cold compress, ice bag to neck, ice pills, hot pack, lavage, sulfonal, codein, morphine, etc. Then when the patient was in a condition of semi-coma, and hope had been given up, an osteopath stopped the spasms in ten minutes by extension of the cervical region, overcoming the tension which tightened the vertebræ to such an extent as to bring pressure interference at the origin of the fibers of the phrenic nerve, which, as you know, is motor to the diaphragm. This was simply a matter of mechanics. I do not cite this case for the purpose of arguing that the classical methods of treatment are incorrect or do not produce results, or for the purpose of insisting that the mechanical treatment is the *only* one, but for the purpose of illustrating to you that in your consideration of traditional therapeutics it does not seem logical to overlook the mechanical possibilities in any condition where the human machine is not running smoothly.

I have just stumbled across the surprising fact that

the basic principle of osteopathy was publicly announced by an eminent authority in the regular school of medicine about a half a century ago, but the medical world closed its ears and would not hear. It is often said by critics of osteopathy, that if its principles were true, it would have been espoused by the regular profession. Herewith is the answer to these critics—the public announcement in the regular profession of the osteopathic theory and its successful application, long before the founding of the osteopathic school, followed by the fact of the refusal of the orthodox practitioners to pay any attention to it, necessitating the foundation of a separate school of practice.

Way back in 1861, when the future founder of osteopathy was himself a practitioner of the old school, and a surgeon in the Union army, a volume was published in London by Edward W. Tuson, F.R. C.S., surgeon of the Middlesex Hospital, an eminent anatomist and orthopedist, and the author of a number of standard works. The title of this book was "Spinal Debility." I discovered an old copy of it on the dusty shelf of a second-hand book store. On the first page of the preface, the author announces the osteopathic theory in these words:

"One of the objects the author has in view is to inculcate the necessity of more frequently examining the vertebral column, in cases of spasm, epilepsy, paralysis and other distressing symptoms, which may often be traced to pressure on the spinal nerves and relieved by the means narrated."

Later on in the work he says:

"Many cases have come under treatment of this kind, where the patients have been suffering for months, and even years, without receiving any benefits from medicines; yet when the spinal column has been supported, the patients have recovered rapidly under judicious general treatment, have been soon restored to perfect health.

"How many cases are there, where a general debility and wasting away of the body takes place without any assignable cause, which can only be explained by the facts already mentioned, and which may be relieved by proper means, indicated by the prevailing symptoms. Once establish this truth, that the nervous disorders proceed from some hidden pressure on a nerve or nerves, and then it will be more clearly seen that you must look for the cause, in most instances, to arise from some deviation in the natural curves of the spinal column, and a loss of elasticity in the inter-vertebral substance, producing *pressure on the nerves passing through the inter-vertebral foramina.*"

In confirmation of this rather remarkable announcement so many years ago of what is looked upon as new to-day, I also ran across the following quotation from Richard P. Player, in the *Quarterly Journal of Science,* London, in an issue not many years distant from the date of the work just mentioned. He says in part:

"The occurrence of pain in distant parts forcibly attracted my observation, and induced frequent examination of the spinal column and after some years' attention I consider myself enabled to state that in a great number of diseases, morbid symptoms may be discovered about the origins of the nerves which proceed to the affected parts or to those spinal branches which unite with them, and that if the spine be examined, more or less pain will commonly be felt by the patient on the application of pressure about or between those vertebræ from which such nerves emerge. . . . . The cause may exist there. The records of disease abound with cases which combined with daily observations and the discoveries of morbid anatomy, tend to indicate that the cause can, and frequently does, exist very remotely from its phenomena, and that vascular fullness about the origins of nerves can produce the most formidable symptoms in the parts to which they are distributed."

Now, let us see what is being done after half a century to prove in the accepted scientific manner the truth of these theories so clearly enunciated on the other side of the Atlantic. Bulletin, No. 1, of "The A. T. Still Research Institute," which is only to-day received from the press, contains a summary of the research work done by Dr. Carl P. MacConnell, of Chicago, to establish the facts regarding the effect produced upon animals by displacement of vertebræ under ether. I will read the following quotations from Dr. MacConnell:

"For the past six years we have carried on a number of experiments, comprising work on forty dogs and six guinea pigs.

"The purpose of the experiments was to determine, if possible, what actually occurs when structural relations are disturbed, and so maintained, by mechanical or traumatic means.

"After selecting a healthy animal (a small or medium-size dog is best), surgical anesthesia is necessary.

"The immediate noticeable results are malalignment of the vertebra, malposition of the ribs corresponding to the damaged vertebræ if the lesion is a dorsal one, and contraction of the spinal muscles of the same segments. These changes are readily palpated.

"The periods of observation have ranged from three to

eighty days—that is, the time from production of the lesion to autopsy.

"Before the lesion is dissected a thorough autopsy is made in each instance and specimens secured of various organs and tissues, whether they show any pathological changes or not, or correspond nervously with the lesion.

"In the lesion itself we fail to see where there is any perceptible partial occlusion by the encroaching bony tissues in the great majority of cases. Slight tension of the incased fibrous tissue anchoring the structures passing through the opening may readily occur. This in itself, in one sense, will act as an occluding factor. But careful microscopic examination does not reveal any greater damage to nerves or vessels here than at several other places, and the theory of pressure or inhibitory lesion *per se* at this particular area is untenable. Strain of the spinal-column muscles alone, especially an unbalanced tension, will unquestionably produce a temporary lesion, but not often a permanent one. After a number of days' rest the muscles will, to a great extent, return to the normal, unless there is a very active disturbing factor, such, for example, as considerable inflammation. Even in those cases where there is marked contracture, complete removal of the muscles produces very little, and at times no perceptible, palpable change in the vertebral rigidity. This does not apply, however, to ribs, for removal of the intercostal muscles allows comparative freedom of the range of rib movement, owing to the relatively small articulating surface. Consequently, it is found that the permanent vertebral lesion is maintained by overstretched and damaged articular ligaments. Sever either the capsule of the articular processes or the ligaments of the vertebral bodies and considerable motion is immediately obtained. The ligaments of the articular processes are the ones most damaged. The intervertebral carti- itself is usually only slightly damaged. The cartilages of the articular surfaces are commonly little involved. This last statement, however, applies to slight and moderate lesions. Naturally, in more severe injuries ankylosis occurs, which happened in two of the animals. These observations apply particularly to the dorsal and lumbar sections. The cervical region is different structurally; here, for one feature, larger and stronger muscles is an important consideration. Uneven traction of cervical muscles followed by contracture can easily produce and maintain an osseous lesion. Finally, one other point in the lesion dissection is frequently noted, hemorrhagic points within the tissue surrounding the dorsal and ventral root bundles and within the membranes of the cord (notably between the pia and arachnoid).

"Naturally, the greatest interest centers in the microscopical findings of the nerves and blood vessels. The Marchi, Weigert-Pal, Williamson, and Nissl methods show, without question, that the nervous structures of the spinal cord, the spinal nerve roots and their branches, and the sympathetics corresponding to the lesion, are pathologically involved;

while nervous tissues of normal animals, fixed, stained and mounted in the same material and at the same time, show no change. Various cell groups in the gray matter are disturbed; some are more or less swollen, others partly atrophied, and a number normal (Williamson and Nissl's methods). Corresponding axone degeneration (beginning parenchymatous; Marchi, Donaggio and Weigert-Pal methods) is readily noted, and extending above and below the lesion. Our studies of the cord have embraced only one, two or three segments above and below the lesion. These changes can readily be classed as primary degeneration, which means that the nerve

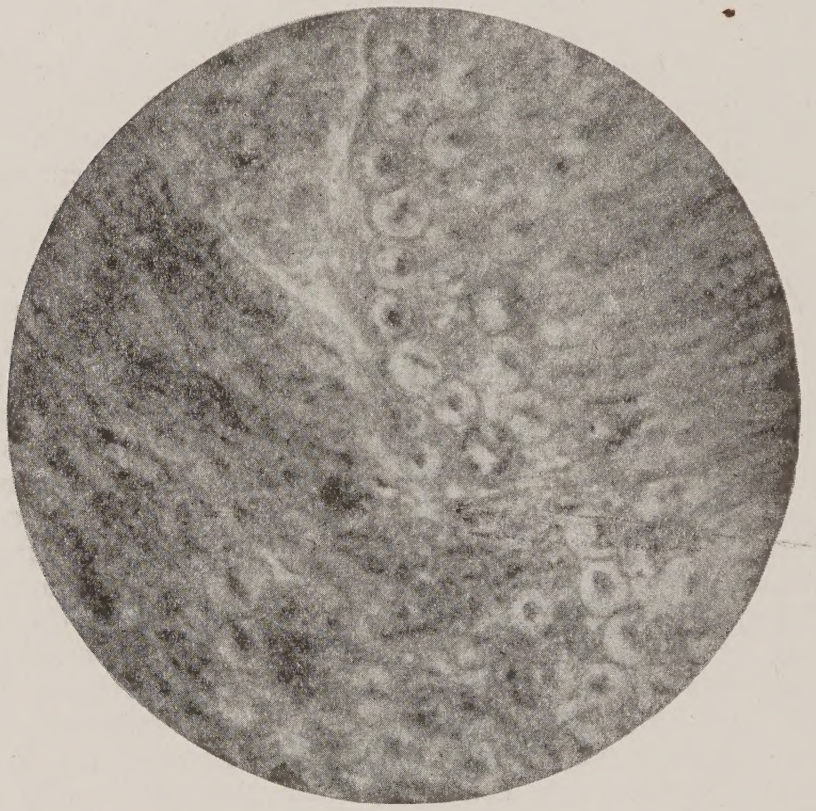

FIG. 20.—Section from the nerve branch supplying the back muscles. A group of these nerve fibers are normal; others are degenerated. Marchi. X 350.

The above and following photomicropgraphs show result produced two months after vertebral displacement.

(By permission from A. T. Still Research Bulletin No. 1.)

cells are nutritionally disturbed. They are not, as a rule, very extensive or severe, but can readily be traced from the nerve centers in the cord and posterior root ganglion and sympathetics. In many instances they do not include the entire bundle of axones, but one-third, one-half, or two-thirds; in some an entire cable is degenerated. The posterior nerve roots are most affected, frequently all the fibers. The anterior roots are usually less involved, commonly bundles of fibers, not the entire section. In cases where the lesion is more severe or the back being stiff for more than two vertebræ, the neighboring spinal nerves are found more or less

degenerated. We have not been able to always clearly trace the degenerated paths in the cord (one reason being the paths in the dog are not so clearly defined as in the human). But two paths of degeneration are readily noted, viz.: Fibers in the posterior column and bundles of fibers from the anterior horn. The degenerated fibers of the sympathetics appear to be largely those of the vasomotors (fine medullated groups, Marchi method), but this is a difficult point to positively decide. These early changes are, as a rule, a simple beginning primary parenchymatous involvement, and no doubt are

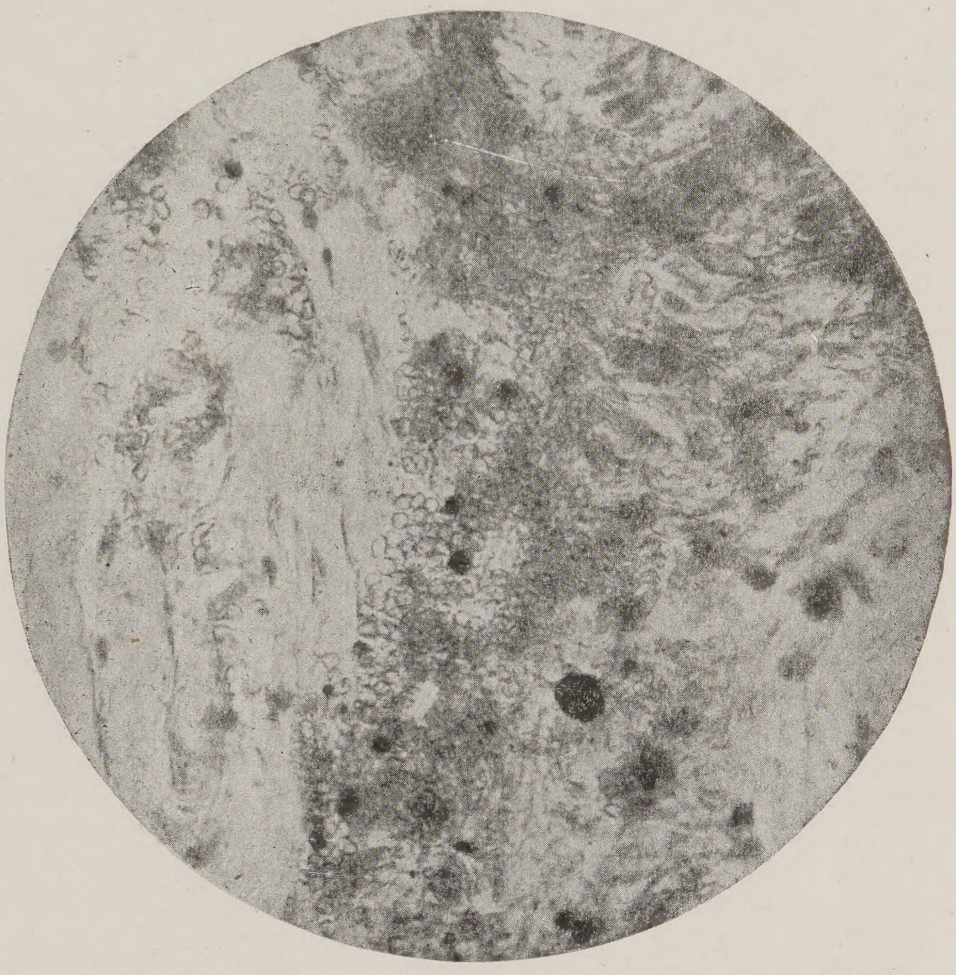

FIG. 22.—Diapedesis and leucocytal invasion into the sympathetic ganglion. A number of degenerated medullated fibers are seen. Most of the fibers are not medullated. Marchi, with lithium carmine. X 325.

amenable, in the majority of cases, to recovery when the disturbed nutrition is rectified.

"The changes found in the blood-vessels are a highly interesting and elucidating study. The coats of arterioles, capillaries, veins, and in some instances the arteries, are found deranged from the endothelial cells through the muscle fibers and the outer layer into the surrounding tissue. And in the walls, through and into the surrounding tissues, are found, in variable quantities, blood corpuscles enmeshed. From an escape of blood plasma to leucocytal invasion, diapedesis and hemorrhagic foci, the pathologic picture is evident. The

change is not an intensely destructive one, or one beyond a stage of repair. The entire transverse wall is not, as a rule, involved, only a portion. In a number of the smaller arteries there is a well-defined endarteritis. The involvement is a hyperemic one, in all probability dependent upon vessel relaxation and atony, followed by plasma leakage between endothelial cells and escape of corpuscles. This distortion in localized areas of the vessel wall structures is undoubtedly pathologic, due to the varying diapedetic activity. It is especially interesting to note that the greatest diapedesis, so far as nervous tissue destruction is concerned, occurs about and through the ganglionic regious of spinal cord, posterior root ganglion and sympathetics. This vessel disturbance always largely corresponds to the lesion so far as the involved spinal foramen (both sides) and the injured ligaments and muscles are concerned. In many of the dissections the nerves, vessels and connective tissue of the spinal foramen are removed intact, likewise the sympathetics and the tissues of the back, so that thorough and comprehensive pictures of the lesion are thereby secured. The rich nerve and vessel supply to and through the fascia is an interesting study in itself. All of the pathologic changes do not correspond absolutely to the lesion, but the changes above and below are much less marked, and undoubtedly are due to either extension of the traumatic lesion or to related nerve paths. In those cases where the mechanical injury is not entirely confined to a single articulation, pathologic involvement elsewhere is noted corresponding to location and degree of initial damage. Then, of course, as stated, there is the ramification of fibers above and below the segment, which should be remembered. The disturbance to the vessels of the sympathetic seems to be just as well marked, but it is to be noted that they are less severe in the adjacent segments above and below. The extension of this vaso-motor affection to nervously related viscera (for example, the stomach and kidneys) is frequently detected; but visceral lesions will be discussed presently.

"The hyperemia in the spinal cord is pronounced, especially in the gray matter. Throughout the posterior horns and in the tips and mesial sides of the anterior horns are the areas most disturbed, but not by any means exclusively. The circulatory changes vary in different cell groups. This ischemia is greatest in the corresponding segment, and gradually lessens to a segment, sometimes two, above and below the lesion. Congestion, with more or less diapedesis of the anterior and posterior spinal cord vessels, is readily noted. In most cases the posterior vessels, apparently suffer the more, the same as the posterior nerve fibers. The additional strain to the anchorage and connective tissues in the spinal foramen may partly account for this; it may be due partly to the peculiarities of vessel distribution and termination, and to the fact that the spinal veins have no valves. Anticipating, for a moment, a portion of the theoretical conclusion, for the sake of emphasis, it would appear that the damage, inceptively and primarily,

would be due to the blockage of the afferent sensory impulses of the joint structure and encompassing tissues, followed by reflex segmental disturbance to the efferent vaso-motor, motor and other fibers. In this connection it would be interesting to know the relative severity of nerve cell and nerve fiber change due to a disordered viscus, affecting reflexly the viscero-sensory and viscero-motor reflexes. Hyperesthesia and muscular contraction of the spinal tissues arising from viscus disturbance is a frequent observation, and we profit clinically by these symptoms. Severance of the afferent fibers from viscus to cord, and a histological study of its effects, would probably instruct us considerably.

"The microscopic muscular changes are clear and well defined. The contracture is due to an interstitial myositis, wherein is easily seen increase of connective tissue and atrophy of the muscle fibers.

"The effect upon stomach and intestines is marked. First, clinical analysis shows that secretory, motor and digestive powers are altered and lessened; that is, of course, if the lesion is a fairly deep-seated one, affecting the stomach innervation. Then the histologic examination reveals one or more characteristic pathologic changes. In the lesser changes, as in all, we note vessel congestion in the submucous coat. Usually accompanying this is diapedesis. In the more marked cases the cells of the mucous coat are nutritionally involved; there are areas of feeble staining and parenchymatous changes, with accompanying pathologic disorder. This is found in areas of both the stomach and intestines. These changes, like all the visceral ones found, are definite acute ante-mortem lesions. At most, the period of time from death of the animal to the tissue being placed in the fixing fluid is only a few minutes.

"The kidney changes are very interesting. These have taken place when the lesion was produced in the section comprising the eleventh, twelfth and thirteenth dorsals only. It would seem without question that the vaso-motors are principally at fault—that is, the initial nervous lesion affecting the kidney is by way of these fibers. The disturbance is a vascular one, resulting in congestion and a typical hemorrhagic infiltration. The nephritis, of course, is acute, and the urinary findings are characteristic of such. The urinary changes are commonly manifested the third day, sometimes the fourth and fifth. In two cases correction of the lesion was attempted, and in ten and fifteen days respectively the urine was negative and remained so. An interesting point to note is that the vascular disorder seems to occur first in the glomerulus, and between the glomerulus and capsule; then throughout the tubules. There is probably an anatomical reason for this, due to the vessel's distribution and ending in the tuft.

"The liver and spleen in a number of instances were found congested. The liver, especially in areas in the middle lobe, was involved, and in the cellular tissue nutritionally affected. This was shown by feeble staining and perivascular infiltration.

"In two cases the pancreas was found acutely disordered. There was considerable congestion throughout several of the islands of Langerhans (and further study and experiments may reveal this precedes the atrophic changes noted by Opie). The urinalysis after the fourth day showed a moderate amount of sugar.

"The adrenals in one case of lesion of the lower dorsal showed a small amount of congestion.

"A parenchymatous goiter was definitely produced in two of the animals. One of these had a lesion between the second and third cervicals, the other between the first and second dorsals. In both of them several of the near-by lymphatics were enlarged. Occasionally the lymphatics, especially near the liver and intestines, when these organs were disturbed, showed enlargement."